Minimal incision aortic surgery

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Purpose: **In this study we evaluated the clinical and economic impact of minimal incision aortic surgery (MIAS) for treatment of patients with abdominal aortic aneurysms (AAAs) and aortoiliac occlusive disease (AIOD).**
Method: **Fifty patients with either AAA (34) or AIOD (16), prospectively treated with the MIAS technique, were compared with 50 patients (40 AAA and 10 AIOD) treated in the same time period with long midline incision and extracavitary small bowel retraction. MIAS was also compared with a cohort of 32 patients with AAA treated by means of endoaortic stent-grafts. Outcomes and cost (based on metric mean length of stay) were compared for the open and endoaortic techniques.**
Results: **Patients who experienced no perioperative complications after the MIAS or endovascular repair technique had shorter hospital stays than patients with uncomplicated aortic repairs performed with a traditional long midline abdominal incision (3 days vs 3 days vs 7.2 days). Hospital stay was also significantly shorter for the less invasive procedures when perioperative complications were included (4.8 days vs 4.3 days vs 9.3 days). The MIAS and endovascular aortic repair groups had a shorter intensive care unit stay (≤ 1.0 day) and a quicker return to general dietary feeding (2.5 days) than patients treated with standard open repair (1.8 days, 4.7 days). The overall morbidity for the MIAS technique (14%) and endovascular technique (21%) was not significantly different from standard open repair (24%). The mortality rate for the different treatment groups was equivalent (MIAS, 2%; endovascular repair, 3%; standard repair, 2%). The MIAS was more cost-efficient than standard open repair ($12,585 vs $18,445) because of shorter intensive care unit and hospital stay and was more cost-efficient than endoaortic repair ($12,585 vs $32,040) because of reduced, direct intraoperative costs.**
Conclusions: **MIAS is as safe as standard open or endovascular repair in the treatment of AAA and AIOD. MIAS is more cost-efficient than standard open or endoaortic repair. (J Vasc Surg 2001;34:47-53.)**

The growth and development of catheter-based technology for the treatment of arterial disease have generated tremendous enthusiasm for less invasive methods of aortic reconstruction. Although clinical trials have clearly demonstrated that endograft repair of aneurysms is feasible and safe, long-term durability and performance have not yet been established. Furthermore, it has not been proven that such therapeutic modalities have reduced morbidity and mortality when treating high-risk patients or have significantly reduced the intensity, duration, and cost of treating less critically ill patients with aortic disease. With the emergence of endoaortic repair alternatives it is important to reevaluate more traditional surgical techniques and to determine whether procedural modification might preserve outcome quality and, at the same time, improve patient satisfaction and cost efficiency. In this study we evaluated the clinical outcome and economic impact of using a less invasive method of aortic exposure for routine treatment of patients with abdominal aneurysms or aortoiliac occlusive disease (AIOD).

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METHODS

Surgical technique. In minimal incision aortic surgery (MIAS), a small midline periumbilical incision; intracavitary retraction of small bowel for exposure of the infrarenal aorta; and open, handsewn polyester fiber (Dacron) graft anastomoses are used. The configuration of the abdominal incision is based on the disease to be treated. When aneurysms are confined to the infrarenal aorta, the periumbilical incision is expanded cephalad for approximately 8 cm. When aneurysmal dilatation extends into the common iliac branches or when AIOD is present, the periumbilical incision is extended caudad for the same distance. The incision should be just large enough for one hand. The average length of the abdominal incision is 10 cm (range, 8-12 cm). The small bowel is manipulated to the right of the abdominal aorta, and a rubber Fish abdominal closure pad is scrolled and inserted into the abdomen, allowing it to expand vertically to the right of the aorta. This semirigid barrier effectively prevents small bowel from entering the surgical field. The low-profile Bookwalter abdominal retractor is fixed into place with the small circular ring placed over the abdominal incision, and deep speculum blades are placed at the 2-o'clock, 5-o'clock, 8-o'clock, and 11-o'clock positions. An appropriately sized Dacron graft is selected, the patient is systemically anticoagulated, then the infrarenal aortic neck and the aortic branch vessels are cross-clamped with the atraumatic low-profile Cosgrove arterial clamps. For patients with aneurysms, the sack is opened, its contents removed, and back-bleeding lumbar vessels are ligated with sutures by means of long instrumentation so that the

surgeon's hands function at or above the level of the abdominal wall. A laparoscopic knot-cincher can facilitate ligature fixation in deep wounds. Proximal and distal aortic anastomoses are performed with 2.0 polypropylene (Prolene) sutures. When aneurysmal disease extends into the iliac arteries or when patients with AIOD are treated, the surgeon must decide whether the iliac or femoral vessels should be selected for distal graft placement. The small abdominal incision makes suturing at the distal common iliac artery level difficult. When distal iliac disease is present, it is easier to ligate the iliac arteries and to use the common femoral artery for distal anastomoses. Bifurcated graft limbs can be tunneled through the retroperitoneum across the pelvis without difficulty with a curved aortic vascular clamp. The aortic sac, retroperitoneal tissue, or both are used to cover the graft, and the abdominal wall is closed with figure eight internal retention sutures.[1]

Patients undergoing MIAS are extubated in the operating room. Nasogastric tubes are removed in the recovery room or during rounds the first postoperative day. Epidural catheters are not used. Bupivacaine hydrochloride (Marcaine) at ½% is injected into the abdominal incision at the time of closure, and intravenous patient-controlled anesthesia is used for 1 or 2 days postoperatively for pain control purposes.

Endovascular-treated patients had endotracheal tubes and nasogastric tubes removed in the operating room. Epidural catheters were not routinely used. Standard open repair patients were extubated in the operating room. Nasogastric tubes were removed routinely on the third postoperative day. Epidural catheters were used in 85% of the standard open repair group.

Clinical study. A consecutive, prospective, nonrandomized cohort of 50 patients with abdominal aortic aneurysm (AAA) (34) and AIOD (16) treated by a single surgeon using the MIAS technique was compared with 50 patients (40, AAA; 10, AIOD) treated in the same time frame (June 1999 to June 2000) with traditional long midline abdominal incisions and extracavitary retraction of small bowel for aortic exposure. These patients were treated by all surgeons within the practice group who used the same operative technique and a standardized pathway algorithm for postoperative care. These two groups were compared with 32 consecutive patients with aortic aneurysms who were treated with AneuRx or Ancure stent endografts. Endoaortic repairs were performed by a single surgeon in the same clinical group. Because the MIAS and endoaortic repair techniques were new to our clinical practice, a single surgeon was designated to perform each of the new skill procedures. Each surgeon was committed to use the "new technique" unless exclusionary criteria dictated otherwise. Global exclusionary criteria for this comparison study included ruptured aneurysms, pararenal or suprarenal aneurysms, and patients who required concomitant mesenteric renal or infrainguinal arterial reconstruction. Specific exclusionary criteria for endoaortic repair included a short infrarenal aortic neck (< 1.5 cm), a dilated aortic neck (> 26 mm), or small tortuous iliac arteries less than 6 mm in diameter. No attempt was made to risk stratify entry of patients into any treatment group. Demographic characteristics, including age, sex, body weight, aneurysm size, and comorbid risk factors for the three study groups, were compared. Parameters, including operating time, intraoperative fluid administration, transfusion requirements, intensive care unit (ICU) length of stay, return to regular dietary feeding, and hospital length of stay, were recorded. Early postoperative morbidity and mortality rates (< 30 days) were compared among the groups. Patient demographics were compared with a Fisher exact test. Operative parameters were compared with a 2-tailed Student *t* test. Average time interval to regular diet, ICU stay, and length of hospital stay were compared with the Wilcoxon rank sum test. Other analyses were performed with SAS statistical software (SAS Institute Inc, Cary, NC). The data analyzed with the Student *t* tests revealed *P* values less than .05 to be significant.

Medical reimbursement recorded as Total Standard Cost per patient for the principle diagnosis of unruptured AAA (*International Classification of Diseases, Ninth Revision* #441.4) was calculated on the basis of metric mean length of stay, which is a statistically adjusted value for all cases of a given diagnosis-related group (110, 111 = AAA with or without complications). Cost data were provided by the University Health System Consortium, which is the national agency that provides cost-related data for all major university health care providers in the United States. Information from the Hospital Cost Report Information System was used to estimate cost from reported hospital charges. Cost determination (Total Direct and Indirect Cost) for patient populations is built from the costs of individual encounters; the cost of an individual patient encounter is estimated from the sum of costs assigned to each billable item or service that the patient received during the stay. The following cost measures are used when reporting on populations, individual cases, or specific services: Our total actual cost is an approximate measure of fully allocated costs of providing services to patients including all direct costs of care (patient care staff, disposable medical supplies, drugs, medical equipment) plus an allocation of indirect or support costs (eg, administration, medical records, information systems, and facility cost such as building depreciation and utilities) Actual direct cost plus actual indirect cost equals actual total cost. Net hospital revenue is a product of the total hospital reimbursement minus the total actual cost per patient.

RESULTS

There was no significant difference among the MIAS, standard open repair, and endoaortic repair groups regarding age, sex distribution, aneurysm size, or body weight. Male sex was prevalent in all three groups. The endovascular repair group tended to be older and to have more significant comorbid risk factors than the standard repair or MIAS study group, but these trends were not

Table I. Demographics

	MIAS	*Standard repair*	*Endovascular repair*
No. of patients	50	50	32
Age (y)	65 (± 10)	67 (± 12)	71 (± 9.8)
Sex			
Male	36	33	30
Female	14	17	2
Aneurysm size (cm)			
Range	(4.0-8.2)	(4.2-9.0)	(4.5-8.4)
Median	5.7	6.2	6.2
Body weight (kg)			
Range	(52-110)	(60-105)	(70-150)
Median	87.5	85	91.9
CAD	52%	33%	72%
HTN	70%	67%	38%
AODM	9%	10%	28%
COPD	26%	24%	44%
Hostile abdomen	0%	4%	12%

The only significant difference for demographic categories was HTN: $P = .008$. For all other categories $P \geq .133$.
AODM, Adult onset diabetes mellitus; *CAD,* coronary artery disease; *COPD,* chronic obstructive pulmonary disease; *HTN,* hypertension; *MIAS,* minimal incision aortic surgery.

statistically significant (Table I). Tube graft reconstructions were more prevalent in the MIAS and standard repair groups, (31/50 [62%] vs 35/50 [70%]), whereas bifurcated stent-grafts were used in all 32 endoaortic repairs. Surgical exposure of the common femoral arteries was required more commonly in the MIAS and endoaortic treatment groups (19/50 [38%] vs 32 [100%]) than in the standard open repair group (7/50 [14%]). One minor groin wound complication developed in the MIAS cohort (epidermolysis, 2.6%), and two major groin complications developed in the endoaortic repair group (wound infection, seroma, 3.1%). Although procedural times tended to be longer for the endograft repair, there was no significant difference in operating room time (minutes) among the three groups (157 ± 37, MIAS; 257 ± 93 endograft repair; 190 ± 64, standard repair). Furthermore, there was no significant difference in intraoperative fluid use or transfusion requirements among the treatment groups. Blood transfusion was based on calculated loss. Autotransfusion was used in the MIAS and standard open repair groups. Intraoperative fluid administration varied considerably according to anesthesia staff and did not necessarily reflect physiologic need. ICU stay, return to general dietary feeding, and hospital length of stay for the MIAS and endoaortic technique groups were significantly lower than those in the standard open repair group. Morbidity and mortality rates were not significantly different for the three study groups (MIAS, 14%/2%; endoaortic repair, 21%/3%; standard repair, 24%/2%) (Table II).

Total Standard Cost per patient was lowest for the MIAS procedure and highest for the endoaortic repair technique, despite the fact that ICU use and hospital length of stay were comparable. This discrepancy between reduced cost indicators (ICU stay and hospital length of stay) and increased total cost is explained by increased direct cost incurred in the operating room (Table III). Our hospital recognized a greater net profit for the MIAS procedure than for standard open repair because of reduced resource use and reduced hospital length of stay. Despite a similar reduction in resource use and length of stay, endoaortic procedures resulted in a net loss because of excessive device delivery cost.

DISCUSSION

Until Parodi et al's[2] introduction of endograph repair of aortic aneurysms in 1991, little effort had been made to change critical procedural components of aortic surgery. Although the safety and durability of open aortic procedures have clearly been established over the past three decades, enthusiasm for catheter-based treatments of aortic disease has created the illusion that operative repair of abdominal aneurysms or AIOD may be dated and possibly inappropriate despite the fact that long-term follow-up for endoaortic procedures does not exist.[3,4] Because of the uncertainty about the durable function of aortic endografts,[5-10] a rekindled interest in procedural modification of more standard operative techniques has developed,[11-13] with the objective being to improve patient recovery and satisfaction while lowering hospital stay and cost without an adverse impact on clinical outcome. Until long-term durability, safety, and performance can be established for endoaortic techniques, this effort may provide the surgeon and health care delivery systems with additional treatment options that can be selectively used for optimum care of any given patient.

Contemporary procedural changes in operative technique designed to improve recovery from abdominal aortic surgery include the midline retroperitoneal exposure,[11] laparoscopically assisted open aortic repair, and retroperitoneal laparoscopic repair.[12,13] These limited clinical trials suggest that postoperative ileus can be prevented and that hospital stay can be significantly shortened. However, pro-

Table II. Clinical outcomes (≤ 30 days)

	MIAS (d)	P *value* ↔	*Standard repair (d)*	P *value* ↔	*Endovascular repair (d)*
ICU stay	1.0 ± 1.2	.0296	1.8 ± 1.5	.0251	1.1 ± 0.7
Postoperative general diet	3.0 ± 1.3	.0036	4.7 ± 2.8	.0011	2.0 ± 0.5
LOS, all patients	4.8 ± 1.9	.0011	9.7 ± 4.6	.0001	4.3 ± 3.7
LOS, uncomplicated	3.0 ± 1.0		7.2 ± 1.2		3.0 ± 1.0
Mortality rate	1 = 2%*	NS	1 = 2%†	NS	1 = 3%†
Morbidity rate	14%	NS	24%	NS	19%
Wound complication	1		1		2
ETOH withdrawal	1		—		—
UTI	—		1		—
Ileus	1		4		2
HTN	1		1		1
↑Ventilation assistance	1		3		1
Graft limb occlusion‡	—		—		3
Endoleak‡	—		—		3 2 type 1, 1 type 2
CHF/atrial fibrillation	1		2		1
Distal embolus	1		—		—
Transfusion (units)	0.9 ± .9	NS	0.9 ± 1.4	NS	0.9 ± .7
Intraoperative fluids (cc)	3560 ± 1625	NS	4105 ± 1034	NS	3483 ± 1562

*Coagulopathy.
†Myocardial infarction.
‡Technical endovascular complications corrected in operating room not included in morbidity.
HTN, hypertension; *CHF,* congestive heart failure; *ICU,* intensive care unit; *LOS,* length of stay; *NS, P* ≥ .1000; *UTI,* urinary tract infection.

longed operative times and anesthesia requirements, as well as the need for advanced laparoscopic skills, make routine use of such techniques less desirable for routine treatment of patients with AAAs (Table IV).

The MIAS procedure is an attractive alternative for use in the treatment of patients with infrarenal aortic aneurysm disease and AIOD. Laparoscopic equipment is not required. With MIAS, there is complete exposure of the infrarenal aorta and the proximal iliac vessels, equipment commonly found in most operating rooms is used, and technical skills possessed by any competent vascular surgeon are used. The learning curve for retractor placement and the use of long instrumentations can be easily overcome.[14]

The MIAS technique for aortic exposure is best suited for treating infrarenal aneurysms less than 10 cm in diameter and can be used for the treatment of patients with coexisting common iliac aneurysms or occlusive disease. It is not contraindicated for treating patients with previous abdominal surgery. Ten patients (20%) undergoing MIAS had previous major abdominal surgery. The size of the incision is more important to the patient than the surgeon. Incision size correlates with reduced perioperative pain and a quicker return to full postoperative function. The midline incision placement and configuration are important to the surgeon because they effect the exposure of the aorta and iliac branches and allow for easy extension, if necessary, during the conduct of the procedure. The most important aspect of the MIAS exposure is limited manipulation and retraction of small bowel. This reduces postoperative ileus and speeds recovery. Adequate work space and aortic exposure can be achieved through a minilaparotomy, provided the small bowel can be kept out of the surgical field. The Fish rubber pad, originally used for abdominal wound closures, has turned out to be an effective retaining wall for keeping small bowel out of the surgical field when the MIAS technique is used.

Our experience with this procedure suggests that postoperative ileus reduction is equivalent to retroperitoneal or laparoscopically assisted exposure techniques. Pain management has been simplified with the MIAS exposure. The small incision allows for efficient use of local anesthesia (Marcaine ½%) to control abdominal pain. We have been able to eliminate the use of epidural catheters and, as a consequence, can mobilize patients more quickly and get Foley catheters out faster. The use of MIAS also avoids patient discomfort associated with pneumoperitoneum after laparoscopic procedures. Also, procedural times for MIAS are significantly shorter than any of those described for the laparoscopically assisted or long midline retroperitoneal repairs and no longer than standard open or endoaortic procedures.

In this study, morbidity and mortality rates were not significantly different for patients treated with the MIAS, endovascular repair, or standard open repair technique. The less invasive procedures were effective at reducing postoperative ileus and achieving a quicker return to general dietary feeding. Both significantly reduced ICU utilization and total hospital length of stay.

Before this study, significant reductions in our hospital length of stay for elective open aortic surgery were achieved with the use of clinical pathway care plans (10.1

Table III. Fiscal impact

	MIAS	*Standard repair*	*Endovascular repair*
Total average reimbursement	$21,030	$23,434	$24,777
Total standard cost	$12,585	$18,445	$32,040
Net revenue	+$8,445	+$4,989	–$7,263
			P = .0001
Average cost by department			
OR	$3,068	$3,805	$24,563
CS	$247	$270	$92
RX	$1,377	$1,964	$850
RAD	$601	$814	$482
RecRM	$202	$343	$432
Anesthesia	$893	$1,077	$1,013
Laboratory	$1,020	$1,520	$698
ICU	$3,134	$3,132	$1,256
CV laboratory	$0	$0	$157
Routine	$2,447	$3,770	$1,970
ED	$34	$32	$0
ECG	$57	$92	$24
EEG	$10	$26	$0
Dialysis	$0	$66	$32
Rehabilitation	$140	$178	$77
Respiratory therapy	$432	$563	$195

CS, Central supply; *CV,* cardiovascular; *ECG,* electrocardiogram; *ED,* emergency department; *EEG,* electroencephalogram; *ICU,* intensive care unit; *OR,* operating room; *RAD,* radiology; *RecRM, recovery room; RX,* medicine.

Table IV. Outcomes after less invasive aortic repair

	No. of patients	*OR time (min)*	*ICU stay (d)*	*Regular diet (d)*	*LOS (d)*
MIAS	50	157	1.0	3.0	4.8
Laparoscopic assistance (open)	20	329	2.2	3.0	5.8
Laparoscopic assistance (closed)	60	462	2.4	NS	6.3
Midline (retroperitoneal)	64	347	NS	3.9	NS
Ancure stent-graft	125	211	0.5	2.0	4
AneuRx stent-graft	190	186	0.9	1.4	3.4
UW endovascular repair	32	257	0.9	2.0	4.3

ICU, Intensive care unit; *LOS,* length of stay; *NS,* not stated; *OR,* operating room; *UW,* University of Wisconsin (Madison).

days reduced to 7.2 days). However, until the introduction of less invasive surgical techniques such as the MIAS or endoaortic repairs, further significant reductions in hospital stay were not possible. It does not appear that the less invasive surgical techniques have actually reduced the morbidity or mortality of treating patients with aneurysms or AIOD, but it does appear that they have been effective in reducing postoperative ileus in achieving quicker return to general dietary feeding. Both significantly reduce ICU use and total hospital length of stay. In the cohort of patients specifically evaluated during the time frame of this study, a longer length of stay (9.2 days) was encountered. This did not reflect a change in care strategy and is explained by an increase in disease severity in this treatment group.

In our hospital, the operative room and intensive care costs compromise the most significant fraction of the total cost per patient (MIAS, 46%; endovascular, 84%; standard, 38%). Despite the fact that endovascular repair and MIAS procedures significantly reduce ICU and hospital stay when compared with the standard open repair, only the MIAS procedure actually reduces hospital cost and at the same time enhances net hospital margin. Operating room costs for MIAS and standard open repair are significantly lower than endoaortic repair costs ($3806 vs $24,563), whereas ICU costs for the open procedures are higher than for the endoaortic repairs ($3132 vs $1256). The significant increase in direct cost components of endoaortic repairs simply overwhelms any fiscal advantage achieved by significant reductions in ICU and hospital length of stay.

Although the study is not randomized and has relatively small comparison groups, it does allow for prospective head-to-head comparisons of relatively new techniques that are at similar stages of development in our practice. As our experience with these less invasive procedures expands, it is likely that results will improve for both

the MIAS and endovascular procedures as patient selection and technical skills improve.[15] When MIAS is compared with retroperitoneal or laparoscopic techniques for aortic exposure and repair, MIAS appears more practical because operating times can be significantly reduced and laparoscopic equipment costs and laparoscopic surgical skills eliminated. If alternative aortic exposure techniques require taxing technical skills or added significant additional time requirements, they will not be particularly attractive for routine use. We recommend that MIAS be considered for the elective treatment of patients with moderate-sized infrarenal aortic aneurysms (< 10 cm) and for the treatment of patients with AIOD. MIAS is preferred because of quicker patient recovery, well-established outcomes for traditional graft repair that eliminate the need for lifelong graft surveillance, and improved cost efficiency. MIAS may also be considered as an alternative to standard open repair in the treatment of patients who do not qualify for endovascular grafting because of unfavorable vascular anatomy.

In summary, MIAS should be considered as an additional option for the treatment of patients with aortic disease. It is safe, cost-efficient, reduces recovery time, and maintains outcome quality, thus combining the best attributes of traditional open vascular surgery with those of endoaortic repair in selected patients.

REFERENCES

1. Turnipseed W. A less invasive minilap technique for repair of aortic aneurysms. J Vasc Surg 2001;33:431-4.
2. Parodi JC, Palmaz JC, Barone HD. Transfemoral intraluminal graft implantation for abdominal aortic aneurysms. Ann Vasc Surg 1991;5: 491-9.
3. Zarins CK, White RA, Schwarten D, Kinney E, Diethrich EB, Hodgson KJ, et al. AneuRx stent graft versus open surgical repair of abdominal aortic aneurysms: multicenter prospective clinical trial [see comments]. J Vasc Surg 1999;29:292-305.
4. Moore WS, Rutherford RB. Transfemoral endovascular repair of abdominal aortic aneurysm: results of the North American EVT phase 1 trial. EVT Investigators. J Vasc Surg 1996;23:543-53.
5. May J, White GH, Yu W, Ly CN, Waugh R, Stephen MS, et al. Concurrent comparison of endoluminal versus open repair in the treatment of abdominal aortic aneurysms: analysis of 303 patients by life table method. J Vasc Surg 1998;27:213-20.
6. Becquemin JP, Lapie V, Favre JP, Rousseau H. Mid-term results of a second generation bifurcated endovascular graft for abdominal aortic aneurysm repair: the French Vanguard trial. J Vasc Surg 1999;30: 209-18.
7. Brewster DC, Geller SC, Kaufman JA, Cambria RP, Gertler JP, LaMuraglia GM, et al. Initial experience with endovascular aneurysm repair: comparison of early results with outcome of conventional open repair. J Vasc Surg 1998;27:992-1003.
8. Blum U, Voshage G, Lammer J, Beyersdorf F, Tollner D, Kretschmer G, et al. Endoluminal stent-grafts for infrarenal abdominal aortic aneurysms [see comments]. N Engl J Med 1997;336:13-20.
9. Zarins CK, White RA, Fogarty TJ. Aneurysm rupture after endovascular repair using the AneuRx stent graft. J Vasc Surg 2000;31:960-70.
10. Cuypers P, Buth J, Harris PL, Gevers E, Lahey R. Realistic expectations for patients with stent-graft treatment of abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 1999;17:507-16.
11. Nakajima T, Kawazoe K, Komoda K, Sasaki T, Ohsawa S, Kamada T. Midline retroperitoneal versus midline transperitoneal approach for abdominal aortic aneurysm repair. J Vasc Surg 2000;32:219-23.
12. Kline RG, D'Angelo AJ, Chen MH, Halpern VJ, Cohen JR. Laparoscopically assisted abdominal aortic aneurysm repair: first 20 cases. J Vasc Surg 1998;27:81-7.
13. Castronuovo JJ, James KV, Resnikoff M, McLean ER, Edoga JK. Laparoscopic-assisted abdominal aortic aneurysmectomy. J Vasc Surg 2000;32:224-33.
14. Cerveira JJ, Halpern VJ, Faust G, Cohen JR. Minimal incision abdominal aortic aneurysm repair. J Vasc Surg 1999;30:977-84.
15. Chuter TA, Reilly LM, Faruqi RM, Kerlan RB, Sawhney R, Canto CJ, et al. Endovascular aneurysm repair in high-risk patients. J Vasc Surg 2000;31(1 Pt 1):122-33.

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DISCUSSION

Dr Bruce Gewertz (Chicago, Ill). I enjoyed your presentation and know that you do a terrific job with this procedure. I guess the underlying premise here sort of challenges the surgical rostrum, which is that incisions heal from side to side. I question whether you would speculate as to what it is that is the driver for this better outcome. One might think that it is the intracavitary maintenance of small bowel, which many of us do in our regular open repairs. Is it the Reglan and the preoperative assessment? Or is it like in carotid endarterectomy, an attitude that we take to these patients that is dramatically different? For instance, carotid endarterectomies, we know, used to have a length of stay of 5 or 7 days. Now it has a length of stay where 90% of the patients leave the next day because we mentally prepare them for that and we are prepared with our critical pathways to do that. I would question if you could let us know what you think it is that makes it different that you have a 10-cm incision versus a 20-cm midline incision and if you took the same approach with the patients that you made the larger incisions would they not have the similar salutary outcomes.

Dr William Turnipseed. The answer to all your questions is, yes (laughter). First, if you can prevent or minimize ileus you can get patients out of the hospital quicker. There is no question about that. Certainly patients do have to be prepared for the idea that they do not have to be in the hospital for a long time. Prior to Minimal Incision Aortic Surgery (MIAS), with the use of Reglan and patient preparation, we reduced our hospital length of stay for the standard open repairs from about 9½ days to about 7 days. With MIAS, stay dropped from 7 days to 4 days. About a week ago I did an aneurysm repair in a lady who had laparoscopic cholecystectomy before her aneurysm because of a gallbag full of stones. She had a lap-assisted cholecystectomy. The day she left, she said, "You know, the aneurysm repair was much easier on me than the lap chole," which I figured that is as good a documentation of why you might consider doing this as any.

The size of the incision and the premise that wounds heal side to side reflects a surgeon's perception of the wound. It is not the patient's perception of the wound. What we have found is that the smaller incision has allowed us to more quickly mobilize the patient and to achieve more efficient pain control. The major advantages of the midline approach over the retroperitoneal exposure are a smaller incision with less morbidity; easier extension, if necessary; and the ability to expose more of the aorta and its bifurcation than the retroperitoneal flank incision will allow you to do.

This technique demonstrates that procedural modification in aortic surgery can be effective in altering outcome so as to make it competitive with endovascular repair.

Dr Kenneth Cherry, Jr (Rochester, Minn). Bill, I enjoyed your presentation. You mentioned morbid obesity. In your slide

on patient demographics, although you did not mention it, none of your MIAS patients or your conventional patients were listed as having any obesity at all. There were two zeros, and then all of your obesity was in the other group. My question is this, although the study was prospective, were these highly selected patients, and is any obesity a contraindication?

Dr Turnipseed. This was a consecutive series using the MIAS approach. The definition of obese is the real issue. I can tell you that morbid obesity in Wisconsin is different from morbid obesity in California. We start to think patients are morbidly obese when they get over 300 lb. The most recent patient I did was 250 lb and had 4 in of fat in the retroperitoneum. There was no attempt to select out slender patients, but I would not recommend trying the MIAS technique on a morbidly obese patient for your first case. You can see all of the aorta that you need to through a much smaller incision than you are used to using. By changing the incision and not manipulating the small bowel, ileus can be reduced and better pain control achieved. We have eliminated the use of the epidural anesthesia, and by eliminating epidurals we can get Foley catheters out 2 days earlier and more quickly mobilize the patient.

Dr M. Ashraf Mansour (Maywood, Ill). I enjoyed the paper, Dr Turnipseed. The question I have is, have you had to back out of a patient whom you were planning to do an MIAS for some reason? I guess a picture would be worth 1000 wounds; I would like to see a picture of what this really looks like because I guess with a retroperitoneal approach you can do a small incision and probably achieve more or less the same results.

Dr Turnipseed. In fact, if you measure the incision to do a retroperitoneal exposure, it is two to three times the length of the incision we use, and also, if you look at the literature, there are a number of secondary problems associated with retroperitoneal incisions.

I have had to open one patient who had intravascular coagulopathy where everything thrombosed after we opened flow to the graft. I mean not just the graft, but everything down to this patient's toes, and I wound up having to redo everything. As it turned out, the patient had an occult colon carcinoma that was the probable cause for the coagulopathy.

Dr James McKinsey (Chicago, Ill). Thank you, Dr Turnipseed. Very quickly, limitation of proximal extension, because we always see these aneurysms with an angulated proximal neck, which requires you to go up and over the aneurysm to get to it. Are you limited in your dissection up to the renals as much as we would have done normally through conventional surgery? Two, I would also challenge that the length of stay for the endovascular grafts is quite short since most of us are not putting patients in the ICU at all and they are going home the next day. Have you looked at some of the more recent data rather than the phase II data?

Dr Turnipseed. Yes, I have seen the recent phase II data. Basically our philosophy about using endografts is that they go in the high-risk patients, and we are not doing them routinely in the good-risk, younger patients. Regardless of how you treat aneurysm disease, you are treating the disease, and the technology used does not alter the complications. The reflection of the ICU utilization is higher-risk patient selection.

You can get good proximal exposure by using the retractor to move the incision up and down the aorta. You can pull the aneurysm down with your finger and straighten out the aorta to get a clamp on the neck quite easily.